NCC2-941

NASA-CR-203814

7N-90-CR
021354

Summary Report for

"The Galactic Interstellar Medium: Thermal Processes and Far-Infrared Line Emission"

Principal Investigator: Eddie Loh

Towson State University

Department of Physics

Under the direction of Dr. Eddie Loh (PI: Towson State U.) and in collaboration with Dr. David Hollenbach (NASA/Ames) we have calculated the thermal balance and line emission of the neutral atomic phases of the diffuse interstellar medium. Dr. Mark Wolfire (Towson State U.) has carried the main responsibility for conducting the research and presenting the results. We constructed a multiphase model for the gaseous disk of the Milky Way Galaxy with a goal of determining the thermal pressure and comparing the calculated infrared and X-ray emission with NASA space observations. The models expand our previous work on the local interstellar medium to account for variations with Galactic radius. The thermal equilibrium gas temperature of the neutral diffuse gas was calculated and phase diagrams (thermal pressure versus gas density) were found for gas at galactic radii between 3 and 30 kpc. Our method accounts for the (far-ultraviolet) photoelectric heating from small grains and molecules (Polycyclic Aromatic Hydrocarbons – PAHs) and includes a detailed treatment of the ionization rates and heating due to the soft X-ray background and due to cosmic rays. We explicitly calculated the galactic radial variation in thermal processes resulting from the radial variations of the (1) space density of OB stars, (2) the metallicity and dust to gas ratio, (3) the (FUV) opacity, (4) the atomic and molecular gas surface density, and (5) the gas phase abundances of atomic coolants.

We found that the two neutral phases (cold + warm) can be in pressure equilibrium with a hot ($T = 1 - 2 \times 10^6$ K) pervasive medium for a wide range in galactic radii. The dominant coolant in the cold medium throughout the Galactic plane was found to be the [C II] 158 μm fine-structure transition. The infrared line emission from [C II] 158 μm plus [O I] 63 μm may account for up to half of the cooling in the warm phases. These results, compared with observations of the COBE satellite, are being used to determine the volume fraction of the diffuse phases in the Galactic plane. In addition, we assumed that the hot gas extends high above the plane forming a halo. We took a model for the halo gas in which vertical isothermal columns are in hydrostatic equilibrium in the galactic gravitational potential. Using these simple assumptions, along with the constraint of the existence of two neutral phases, we found that our halo model produces emission which is consistent with the observed soft X-ray background and provides an integrated luminosity from the Galaxy which is comparable to that observed in other spirals.

Colloquia:

"The Galactic Interstellar Gas: What Gets It Hot and What Keeps It Cool" by M. Wolfire - presented at Towson State University.

"The Galactic Interstellar Medium: What Gets It Hot and What Keeps It Cool" by M. Wolfire - presented at University of Maryland at College Park.

Abstracts and Papers:

"The Gaseous Disk of the Milky Way Galaxy" M. Wolfire (NASM and Towson State U.), C. F. McKee (U. of California Berkeley), D. Hollenbach (NASA/Ames), & A. G. G. M. Tielens (NASA/Ames) presented at AAS meeting June 1996, BAAS, vol. #28, 890.

"The Gaseous Disk of the Milky Way Galaxy" M. Wolfire, C. F. McKee, D. Hollenbach, & A. G. G. M. Tielens in preparation to be submitted to ApJ.

"Constraints on the Global Structure of the Interstellar Medium" T.Y. Steiman-Cameron, D. Hollenbach, & M. Wolfire 1997, in preparation to be submitted to ApJ.